AVIATION MAINTENANCE TRAINING CONTINUUM SYSTEM (AMTCS) SOFTWARE MODULE (ASM): AN INNOVATION IN NAVAL AVIATION MAINTENANCE TRAINING

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ABSTRACT

The Aviation Maintenance Training Continuum System (AMTCS) was established to address fundamental issues with reductions in funding and manpower, and lack of formal standardized technical training for sailors and marines beyond the schoolhouse. The AMTCS is comprised of all training and associated infrastructure required to support Naval Aviation Maintenance training. The AMTCS Program provides training and training management tools in the form of interactive courseware (ICW), computer managed instruction (CMI), computer aided instruction (CAI), and the AMTCS Software Module (ASM) to satisfy just-in-time training requirements for the individual technician, and the organization.

At the heart of the AMTCS is the ASM. The primary objective of the ASM is to enhance the quality and efficiency of training at the Schoolhouse and in the Fleet by providing the capability to identify individual maintenance task requirements, perform real time assessment, identify training deficiencies and provide immediate and focused access to training tools. The ASM is a software application tool designed to track technical training exposure across an individuals military career, validate knowledge/skill for all Navy and Marine Corps aviation maintenance personnel, and provide a feedback system to the decision makers to better manage the training business process. This paper will present the functional capabilities of the ASM and the operational concept of the ASM in Aviation Maintenance schoolhouse and fleet environments.

When fully implemented the ASM will be deployed to all Naval, Marine, and Reserve Aviation Maintenance activities. At present, the ASM is deployed at Naval Aviation Maintenance Training Group Detachments. Next year, the ASM will be implemented in F-14, F/A-18 and E-2/C-2 Fleet Squadrons. This paper will include an analysis on the effectiveness of the ASM based on initial feedback from Schoolhouse and Fleet users.

ABOUT THE AUTHORS

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BACKGROUND

In 1993, the Naval Aviation Maintenance community conducted a study to assess the effectiveness and efficiency of aviation maintenance training. This study identified the following limitations and problems in the Aviation Maintenance training pipeline.

- There is a lack of formal standardized technical training for sailors and marines beyond the schoolhouse. Fleet technical training is mostly performed adhoc to support the immediate needs of the individual in the workcenter when time and schedules permit. A significant amount of formal schoolhouse training materials are not readily available to the fleet nor are they appropriate for the on-demand task oriented training needs of the workcenter. Predictably, the quality of fleet training is squadron dependent. Each squadron must implement its own approach to assess training needs, provide the training, and determine when the training need has been satisfied.

- Training material content is not standardized across schools and in the fleet. This means that for similar training objectives the same training materials are not being effectively utilized to achieve the objectives. This problem has relevant implications. One is that time and money could be saved if training materials developed could be used in total or part each time the objectives were covered without regard to when and where the learning occurred. The other implication is related to reinforcement of the learning, if varying rather than common training materials are used to teach the same objectives it is more probable that materials might contain inconsistencies, which confuse the learner rather than reinforce prior learning.

- Training planning and management tools are not easily deployable. Workcenters do not have adequate tools to prescribe, implement and manage a training plan for each individual in the workcenter.

- Training tools are outdated. The majority of Schoolhouse and Fleet training is conducted using low level technology such as paper schematics, publications, and chalkboards. Schoolhouses also utilize panel trainers which are difficult and expensive to maintain.

- Little flexibility in the training program to support the training needs of individuals who don't fit into the one size fits all training pipeline model. There is a lack of training programs in the fleet for apprentice technicians who need additional or remedial training to become proficient at tasks, journeyman technicians who seek additional training or cross training to enhance their knowledge, and for journeyman technicians who require periodic remediation or refresher training to maintain knowledge.

In addition to these issues, reductions in funding and billets have resulted in a trend of migrating training requirements from schoolhouse to fleet. Less instructor billets without a commensurate decrease in the number of students has clogged the training pipeline and made it increasingly difficult for prospective maintenance technicians to receive proper training prior to their first deployment. Simultaneously, there is increased pressure to reduce the time to train students which results in reduced student exposure to necessary information. Training curriculum and lesson plans have been or are in the process of being reviewed to make informed decisions on how to achieve training time reductions without sacrificing training quality.

Reductions within DOD combined with a need to standardize and improve the availability and usability of aviation maintenance training to the fleet spurred the drive to revamp the current aviation maintenance training approach and construct a more innovative continuum concept. In 1994, Chief of Naval Operations and Naval Air Systems Command launched the Computer-based Training (CBT) Systems Initiative (CBTSI) to establish a centralized, integrated infrastructure to support effective, efficient acquisition and management of CBT assets for aviation aircrew and maintenance personnel. The CBTSI objectives for the Aviation Maintenance training arena are:

For the schoolhouse:

- Where appropriate, replace existing panel trainers/training devices with CBT
- Provide for a greater range and depth of instruction and increase training effectiveness/efficiency
- Enhance quality of training

And, for the fleet:

- Provide standardized instruction for In-Service Training
- Enhance quality of training at the unit/squadron level
- Eliminate unit/squadron requirement to develop professional subject lesson guides
- Provide immediate identification of deficiencies
- Provide immediate or on-demand remediation/refresher training
- Provide timely evaluations of training program effectiveness
- Provide personnel performance tracking via CMI

These objectives address the limitations of the current training approach in the schoolhouse and fleet that were identified in the study.

AMTCS OVERVIEW

The Aviation Maintenance Training Continuum System (AMTCS) is an integrated system of computer-based training systems and training tools. AMTCS provides computer-based training systems and training management tools to support schoolhouse and fleet training objectives described in the CBTSI Project Master Plan. The primary objectives of AMTCS are to increase training effectiveness/efficiency and to enhance the overall quality of training using computer-based training technology. The AMTCS Program provides for development, deployment and support of computer- based training systems and training tools for the schoolhouse and the fleet. Primary components of the AMTCS are presented in Figure 1. The AMTCS Training Devices (ATDs) include: Electronic Classrooms (ECRs) and Learning Resource Centers (LRCs) at the schoolhouses, and Fleet Training Devices (FTDs) for use in Fleet work environments. Common to all training devices are the training tools and the AMTCS software module. The AMTCS Software Module (ASM) is a training management tool designed to satisfy fleet and schoolhouse training management needs and provide a mechanism to standardize technical training in the fleet. The integration of Commercial-Off the-Shelf (COTS) hardware and software, CBT tools, ASM software, and Government-Off-the-Shelf (GOTS) tools form the basis of the AMTCS system.

ELECTRONIC CLASSROOM AND LEARNING RESOURCE CENTER

The AMTCS ECR supports five operational states; instructor-led training, self-paced training, training preparation, training management, and training administration. Since the LRC is designed to serve as a backup to the ECR for classroom overflow, it is also capable of supporting all five states. However, the LRC is used primarily to provide training tools for user self-paced remediation. In addition to functioning as a backup ECR and a training tool library, the LRC provides development tools for instructors to review, update, and maintain instructional materials. The primary components of the ECR and LRC are user workstations, instructor lectern, presentation device, video controller, network, network server, CBT materials, and the ASM.

FLEET TRAINING DEVICE

The FTD supports four operational states: self-paced training, group-based training, training management, and training program administration. The primary components of the FTD are user workstations, presentation device, network, network server, CBT materials, and the ASM.

INFORMATION SYSTEMS

The AMTCS includes planned interfaces to two external information systems: Standard Training Activity Support System (STASS), and Naval Aviation Logistics Command Management Information System (NALCOMIS).

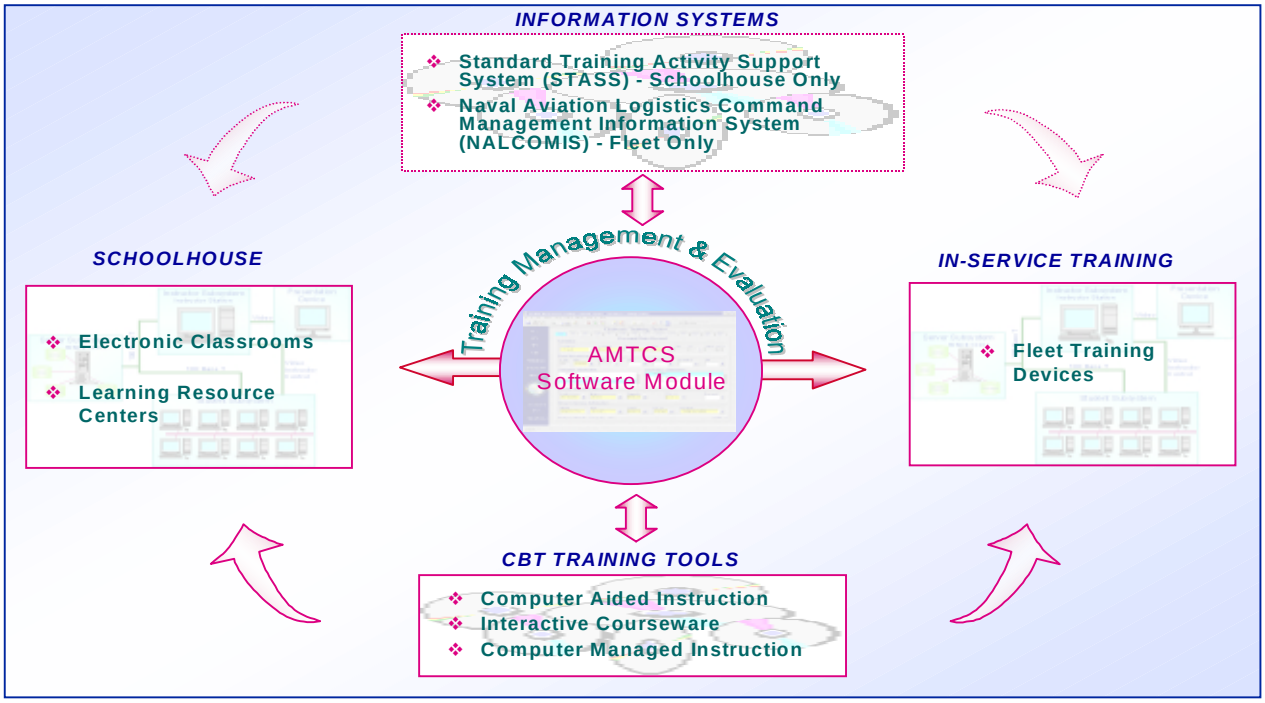

Figure 1. AMTCS Technology Components

An interface to these systems will provide the ability to utilize personnel data and maintenance information already available in the databanks of these systems.

COMPUTER-BASED TRAINING TOOLS

The types of computer-based training tools used in AMTCS are Computer Aided Instruction, Interactive Courseware, and Computer Managed Instruction. ICW tools operate with a CMI Shell to handle topic selection and data collection functions.

AMTCS SOFTWARE MODULE

At the heart of the AMTCS is the AMTCS software module. ASM is a software application which provides schoolhouse and fleet with the capability to:

- Identify individual maintenance task requirements
- Perform real time assessment of an individuals knowledge
- Identify individual knowledge deficiencies
- Identify and provide remediation training for knowledge deficiencies
- Track completion of remedial training
- Track training exposure throughout an individuals military career
- Share knowledge assessment and Feedback data

ASM design is based on open systems architecture principles and a Standard Query Language (SQL) relational database. Figure 2 provides an example of the look and feel of ASM screens.

ASM CONCEPT OF OPERATION

Since the mission of the schoolhouse is training the sailor, while the mission of fleet is operational readiness there are significant differences between these environments in terms of the emphasis placed on training and the processes for managing and conducting training.

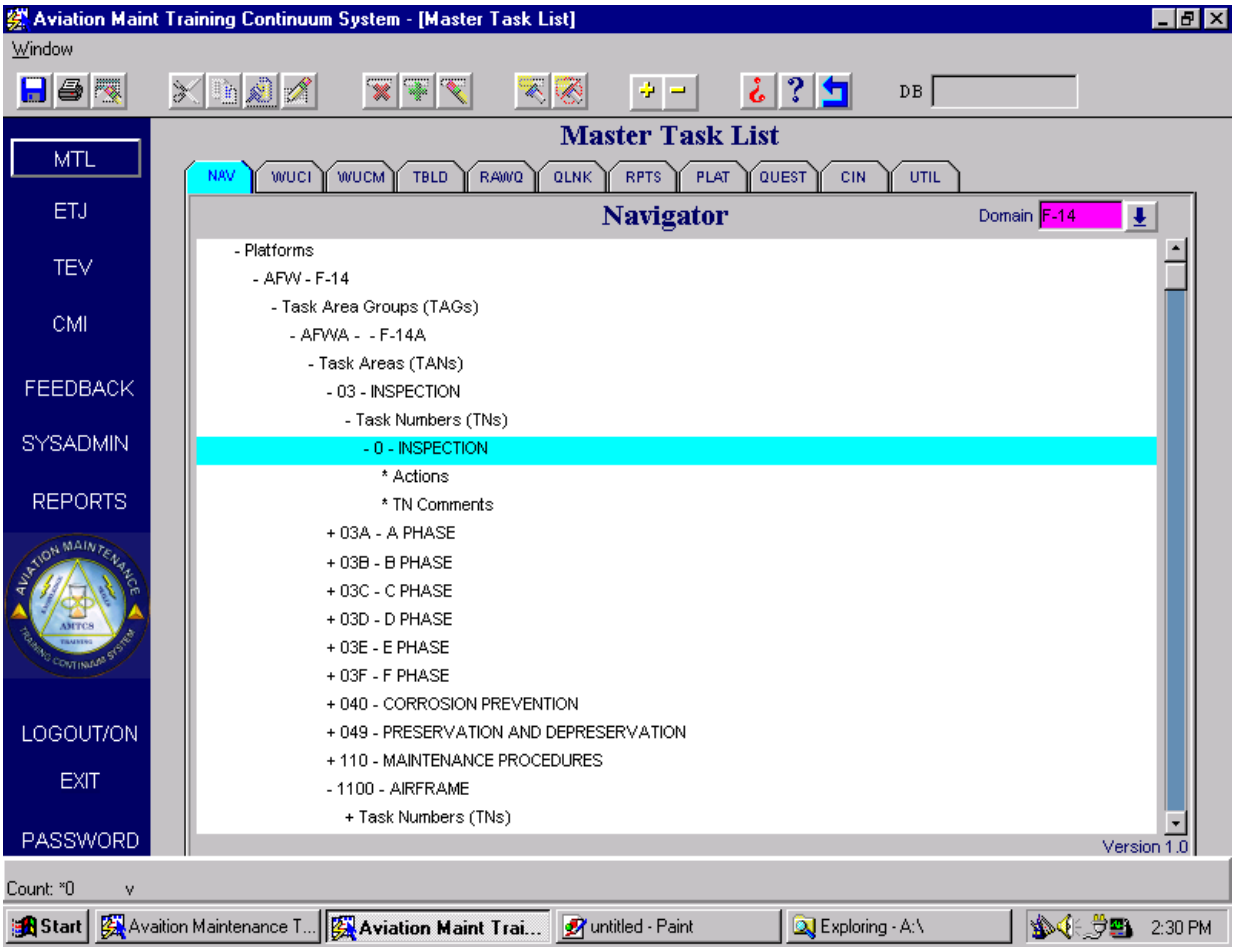

Figure 2. ASM Screen Example

Before ASM design started, a concept of operation for a training management tool was mapped out to determine what the tool was required to do and in what context. From these proposals and subsequent community discussions, evolved a whole new perspective on the processes and procedures required to effectively perform aviation training and training management.

In the fleet, the workcenter supervisor or training petty officer creates an electronic training jacket (ETJ) for each maintenance technician in a workcenter. The ETJ contains personal data, formal training records, informal training records and an Individual Training Plan (ITP). In the ETJ, an Individual Task List (ITL) is created based on the individuals Naval Enlisted Classification (NEC) or Military Occupation Speciality (MOS), billet, rating and collateral duties. The ITL is a list of all the maintenance task actions that a technician is required to perform. Once an ITL is created for an individual, the workcenter supervisor can generate a test to evaluate the technicians' knowledge of the tasks assigned to him. The test is taken on-line or on paper, then graded on-line or through an optical mark reader. Based on test questions missed, the maintenance task action associated with the missed question, and a list of training tools for remediation are available for review. At this point one of two paths may be taken, the supervisor may evaluate the test results and prepare an ITP for the technician that includes remediation from the training tools list, or the technician can start remediation immediately by launching a training tool from the training tools list. After the technician has completed computer-based training, a record indicating topic completion is logged into his ETJ. The supervisor can then view the record to verify training has been completed before reassessing the individual's knowledge.

When a technician is ready to transfer, their ETJ is exported onto portable media so it can be taken to his/her next duty assignment. Table 1 compares the old approach for conducting and managing training in the fleet with the new approach. The new fleet training concept of operation transcends the limitations imposed by the old way of doing things by providing the structure and means to manage and deliver training which meets the learning needs of the individual.

In the schoolhouse, the school administrator creates or imports an ETJ for each student in the schoolhouse database. The ETJ contains personal data, an individual task list, formal training records, and informal training records. The school administrator also creates a course list for the training site and prepares the course roster. The instructor conducts the course using available CBT tools. At various times during the course the instructor will generate and administer class tests. These tests are taken and graded on-line. Test results are stored electronically and are available to the instructor to calculate student grades. After a student completes a course, the school administrator updates the course completion record in the students ETJ. When a student is ready to leave the schoolhouse, the ETJ is exported onto portable media so the student can take it to his/her next duty assignment. Table 2 compares the old approach for conducting and managing training in the schoolhouse with the new approach. The new schoolhouse training concept of operation is not significantly different from the old way, however, it is an improvement in the status quo in that it incorporates the concept of a system which automates manual operations, stores information electronically, and offers CBT tools over conventional tools.

Requirement	Old Method (without ASM)	New Method (with ASM)
Identify which maintenance tasks an individual is required to perform	• Partially documented in a paper-based personnel file through identification of an individuals NEC/MOS, rating, billet and collateral duty • Does not provide mechanism to track an individual's ability to perform assigned maintenance task actions.	• An electronic training jacket contains a record identifying which maintenance task actions an individual is able to perform. • Supervisor is able to create a custom ITL which contains only those maintenance task actions the individual is required to perform.
Identify individual knowledge deficiencies	• Done by supervisor observation of the technicians' performance • Supervisor is able to test technical knowledge to the system level.	• Done by supervisor observation of the technicians' performance • Supervisor is able to test technical knowledge down to tasks within the system.
Identify and assign remediation training for knowledge deficiencies	• The only tools available now are OJT and publications.	• Can immediately assign and launch computer-based training for remediation on failed test questions.
Track completion of remedial training	• No tracking mechanism available.	• Records a completion record when user finishes remedial CBT.
Track training exposure across an individuals military career and store in a training record	• Formal training is tracked in the paper-based personnel file. • Informal training is recorded manually	• All training is recorded in an electronic training jacket.

Table 1 Fleet Old Versus New Training Methodology

Required Capabilities	Old Method (without ASM)	New Method (with ASM)
Identify which maintenance tasks an individual is able to perform	• Partially documented in a paper-based personnel file through identification of an individuals NEC/MOS, rating, billet and collateral duty	• An electronic training jacket contains a record identifying which maintenance task actions an individual is able to perform.
Identify individual knowledge deficiencies	• Instructors conduct paper-based tests and grade them manually to evaluate student technical knowledge.	• Instructors conduct and grade tests on-line to evaluate student technical knowledge.
Identify and assign remediation training for knowledge deficiencies	• Assign review of publications or arrange one-on-one time in the lab.	• In addition to current approaches, can assign computer-based training for remediation on weaknesses.
Track completion of remedial training	• No tracking mechanism available.	• Records a completion record when user finishes remedial CBT.
Track training exposure across an individuals military career and store in a training record	• Formal training is tracked in the paper-based personnel file.	• All training is recorded in an electronic training jacket.

Table 2 Schoolhouse Old Versus New Training Methodology

ASM FUNCTIONS

The AMTCS module contains and integrates four submodules: Master Task List (MTL), Electronic Training Jacket (ETJ), Testing and Evaluation (TEV), and Feedback. The core functionality of these tools are based and designed around actual maintenance tasks the technicians perform. The tasks and their supporting data elements are stored and maintained in the Master Task List (MTL) portion of ASM. The functions and capabilities of each module are described in the following paragraphs.

MASTER TASK LIST (MTL)

The MTL submodule provides the capability to produce a list of maintenance task actions performed on weapons platforms, systems/subsystems, and components. The Navy/Marine Corps numbering schema for identifying systems/subsystems and components within a platform, Type Equipment Code (TEC) and Work Unit Codes (WUCs), is utilized by the ASM to track individual tasks. For non-platform maintenance functions, logical groupings of tasks are utilized which support the same ASM database structure. In the MTL, task lists are linked to action verbs, questions and answers, courses, training tools, Navy Enlisted Codes (NECs)/Ratings, Military Occupational Standards (MOSs), Lowest Grade, Billets, and Collateral Duties. These links are required for the other submodules to function properly. The MTL module is primarily used by developers of the MTL databank. However, within the MTL is a function called Unit Task List (UTL) which allows a command to create a site specific task list for tasks that are unique to the site and not in the MTL e.g. Standing Watch.

ELECTRONIC TRAINING JACKET (ETJ)

The ETJ module records all technical training data throughout an aviation maintenance technicians' career. It contains the individual's personal information, Individual Task List (ITL), Individual Training Plan (ITP), and training history for both formal and informal training. ITLs are created from the MTL and UTL databanks. ITLs are used to identify which tasks an individual is required to perform. The ETJ is designed to be portable so an individual can take it with him from one duty station to the next.

TEST AND EVALUATION (TEV)

In the fleet, the TEV module serves as a diagnostic tool that tests an individual's knowledge within his/her NEC/MOS, Rating, Billet, or Collateral Duty assignments. TEV provides the capability to generate tests, take tests, and grade tests. The test results from TEV are used to determine remediation training needs, update the individual's ITL and ITP, and provide data to the Feedback module.

In the schoolhouse, the TEV module serves as a diagnostic tool that tests a students knowledge within a formal course. Schoolhouse TEV provides the capability to generate, administer, and grade tests within a Course Identification Number (CIN), Test Identification Number (TIN), and Learning Objective (LO). The test results are used to determine remediation training needs, update the individuals ETJ, and provide data to the Feedback module.

FEEDBACK

The Feedback module provides the capability for tracking question/answer effectiveness information. The Feedback module collects question response data for later analysis by the schoolhouse and the fleet.

EXTERNAL INTERFACES

The ASM includes the capability to import individual on-the-job training hours from the Naval Aviation Logistics Command Management Information System (NALCOMIS). From this data the Work Center Supervisor can determine how much skills-based training the individual has been exposed to. ASM has interfaces directly with the Computer Managed Instruction (CMI) tool and indirectly with the CBT via the CMI. This interface allows CBT to be launched directly from ASM and starts data collection in CMI while the CBT is running.

ASM DEPLOYMENTS

In the fall of 1998, ASM Beta testing was completed at two Navy and one Marine squadron, and one schoolhouse. Beta testing involved hands on training followed by extensive operability testing of ASM functions. Following this event, the ASM was acceptance tested by Naval Aviation Maintenance Training Group (NAMTRAGRU) for deployment to the schoolhouse. ASM Version 1.0 was officially accepted and released by Naval Air Systems Command (NAVAIRSYSCOM) for distribution to the schoolhouse in February 1999. Since its release, ASM has been deployed to all NAMTRAGRU detachments for the purpose of creating Master Task Lists for platform specific tasks. ASM is also deployed to Commander Naval Air Atlantic Fleet, Commander Naval Air Pacific Fleet, Marine Corps Combat Development Center, Chief of Naval Air Reserve Forces and NAVAIRSYSCOM for test and evaluation purposes. The first fleet deployment of ASM will be to the F-14, E-2/C-2, and F/A-18 Aviation Maintenance training communities. These deployments are scheduled to commence in April of 2000.

ASM EVALUATION METHODOLOGY

In the spring of 1999, a training analysis exercise was conducted at Naval Air Station, Whidbey Island with participants from several fleet squadrons covering all levels of users. The primary objective of this exercise was to assess the amount of training required to effectively utilize ASM in the fleet. During this event, data was also collected on user response to ASM functions and their perception on its ability to make improvements in training effectiveness and training management in the fleet. A survey was constructed of questions that addressed the quality assurance (QA) factors called out in the ASM Software Requirements Specification (SRS). These factors are functionality, maintainability, usability, reliability, flexibility, and portability. Each question had 5 possible choices: Low, Medium-Low, Medium, Medium-High, and High. If a question was skipped it was counted under the 'Not Applicable' (N/A) column. Scores for each of the questions were calculated by assigning points to each choice (i.e. Low = 10 points, Medium-Low = 25 points, Medium = 50 points, Medium-High = 75 points, and High = 100 points) and then adding up the points and dividing them by the number of people who answered the question. Each question was then grouped by QA factor. After calculating the overall scores for each QA factor they were ranked from Low to High and placed into the following categories:

Category	Score Range
High	76% - 100%
Medium-High	51% - 75%
Medium	26% - 50%
Medium-Low	11% - 25%
Low	0% - 10%

ASM EVALUATION RESULTS

The following list summarizes the final scores obtained for each QA Factor:

QA Factor		Score
Functionality	-	77%
Reliability	-	72%
Maintainability	-	70%
Usability	-	65%
Flexibility	-	77%
Portability	-	85%

The Functionality QA factor refers to the capabilities and features that ASM has to offer. The users scored this factor high because ASM functionally did everything they expected in a training management system. They were impressed by the thoroughness of ASM and by some of its features e.g. launching ICW as a remediation tool immediately after failing a test. Survey comments show that the users could see many benefits in using ASM.

The Reliability QA factor refers to the consistency and reliability of the ASM screens/tabs/menus. The medium-high score reflects the users lack of training in the area of operating the ASM screen/system. Users who were having difficulties with screen operation required assistance in order to proceed. Any screen can be made to operate inconsistently if the wrong buttons are pressed. To improve this score, ASM training must focus heavily on screen idiosyncrasies and their different modes of operation.

The Maintainability QA factor refers to the data entry effort the system will require to maintain it. When interpreting these results, it should be noted, that additional questions were asked to determine if the users felt the time spent on maintaining ASM was worth the effort. Ninety percent of the users did feel it was worth the extra time and effort. Participants stated that the maintainability score could be improved by pre-loading as much data as possible into ASM, prior to deployments, especially in the user account and personal data record areas. This will reduce the initial data entry workload and provide samples for the users while they are becoming familiar with the module.

The Usability QA factor refers to the learning curve and user-friendliness of ASM. This factor received the lowest score. The score reflects the users perspective that the system was difficult to learn on their own with the material provided them. User suggestions for improving this QA factor score were to provide better-organized and thorough training material, provide instructor-led training, and improve the ASM menus/tabs.

The Flexibility QA factor refers to the flexibility of ASM to adapt to the users training needs and reporting requirements. The users scored this factor high and their comments also reflect that they found ASM provided the proper tools for managing their training.

The Portability QA factor refers to the ability to take ASM into differing deployed/land-based operating environments. The users scored this factor high because they liked the portability of ASM on the FTD hardware configuration.

CONCLUSIONS

The exercise results indicate that users are satisfied with the functions that ASM performs and believe it will make training easier to manage and help to develop better-trained technicians. The exercise results also revealed that satisfying functional objectives is not all that the users expect. Users expressed the importance of making the tool easy to use and minimizing the amount of effort required to make the tool useful. Efforts are underway to simplify the user interface and make it more intuitive. In addition, lesson materials to conduct instructor-led training are being developed to assist users with learning the system. Discussions are being conducted with the System Managers of STASS and NALCOMIS to eliminate redundant data entry and reutilize data already available in existing databanks. Establishing an electronic interface between ASM and STASS, and ASM and NALCOMIS will greatly simplify ETJ data entry. An ASM and STASS interface in the schoolhouse will eliminate administrator time spent entering course completion data into STASS when this data already exists in ASM. An ASM interface to NALCOMIS will eliminate personnel record data entry in the fleet and will provide a convenient means to record an individuals on-the-job training hours into their ETJ. Automating data entry functions will eliminate the labor-intensive task of manual data entry, an appealing goal in a downsizing environment.

FUTURE DIRECTIONS

The vision for initial implementation of ASM was to deploy and maintain it locally at each schoolhouse and squadron, with the plan that once the Navy's network infrastructure was in place training systems would be

networked so data could be shared between organizations. In this scenario, multiple AMTCS servers would be linked to store and provide access to ASM data. With the capabilities of Web-based technology, this vision of an ASM network has been replaced with the concept of Web-based ASM. The benefits of making ASM code and the database Web enabled include: centralization of data, ease with managing and distributing ASM version updates, ease of performing configuration management, less costly to support, and less expensive hardware required to operate ASM. Centralization of master task list data would make it easier to field changes to the MTL whenever platform WUC code, or task changes occurred. ETJs could also be stored in a single centralized data repository so trainees would no longer need to carry their ETJ with them between duty stations and risk losing data. Since ASM would no longer physically reside on AMTCS training devices, costly distribution of ASM updates on CD-ROM to multiple sites would be reduced to updating one or two Web servers. In addition, the problem of configuration control and configuration management of training devices with various releases of ASM would be eliminated. With Web-based ASM, every site would have access to the latest version of ASM at the same time. Presently, users call the help desk whenever there is a malfunction with running ASM. Malfunctions generally occur when a user tries to change the configuration of a training device or fails to follow the proper installation procedure for an ASM update. Web-based ASM would eliminate malfunctions due to unauthorized changes in the training device configuration or improper installation of ASM updates. Because of the huge amount of data in the MTL and the complexity of the ASM relational database, local servers have robust technical specifications to run ASM efficiently. These specifications are met by middle to top of the line computer systems, which are costly to the AMTCS Program. Web-based ASM performs data processing functions at the Web server level rather than locally. Top of the line computer systems are only required at the Web server level. Local systems can therefore be reduced to the minimum technical specifications necessary to run CBT.

The MTL module of ASM has already been converted to run on the Web. Naval reserves plan to use Web-based MTL to develop MTLs with Subject Matter Experts from multiple and diverse locations all working on a common databank. Issues with implementing Web-based ASM are the limitations of the current network infrastructure and bandwidth. Navy and Marines are both working quickly to make efficient network service available throughout the forces. However, this is a tremendous effort and there are still many sites without network connectivity. In the Web-based client/server environment the time to process complex operations is limited by the bandwidth available between the client and the server. During peak business hours when network traffic is heavy, the Web-based application will appear to be running slow. If MTL development with Web-based MTL is successful, the AMTCS program plan will proceed with development of Web-based ASM in anticipation that technology investments in the government and industry will overcome these obstacles. As networks and bandwidth become increasingly more available so will Web-based ASM.